EXPLOSIVE COMPOSITION

TECHNICAL FIELD

This invention relates to explosive compositions which include a density controlling component in the form of hulls of de-hulled plant grains. The invention also relates to a method of preparing such explosive compositions.

BACKGROUND ART

Explosive compositions essentially comprise an oxidiser component and a fuel component. The oxidiser component often comprises an ammonium nitrate (hereinafter referred to as AN) compound and the fuel often comprises a fuel oil (hereinafter referred to as FO) such as diesel or the like. A combination of AN and FO is known as ANFO and a 94:6 mass ratio of AN: FO provides an explosive composition with a near perfect oxygen balance.

ANFO is not water resistant and to allow ANFO to be used in damp or wet conditions, the ANFO may be coated with a water-in-oil emulsion. ANFO coated in such an emulsion is known as heavy ANFO or an emulsion explosive. The emulsion may comprise a discontinuous phase of an aqueous oxidiser component dispersed in a continuous phase of an oil component. An emulsifier is usually required to stabilise the water-in-oil emulsion.

It is well known to reduce the density of an explosive composition by adding a density controlling component to the explosive composition. Explosive compositions with a significantly reduced density below 0,8 grams/cc, are suited to be used in conditions where less shock energy or vibrancy is required. By reducing the density of the explosive composition:

- A higher volume of the explosive composition can be used to obtain a better explosive energy distribution in the borehole, which is advantageous over a situation where a lower volume of a more dense explosive composition is located in the base of a bore hole producing a poor explosive energy distribution; or
- It is possible to replace a higher density explosive of a certain volume with a volume of a lower density explosive, to effect a change in energy partitioning, more appropriate for a particular application.

Many different types of density controlling components are known, and such known components are, for example plant-derived matter such as saw dust and nutshells, or non-plant derived matter such as microballoons or polystyrene spheres.

US Patent 5,409,556 discloses the use of expanded grain, such as expanded popcorn, expanded rice or expanded wheat to reduce the density of nitrate based explosives such as ANFO, heavy ANFO and emulsion explosives.

US Patent 4,875,950 discloses an explosive composition which includes certain

bulking agents, comprising from 1-20wt% of a fibrous vegetable protein additive, said bulking agents having a bulk density of from 0,1 to 0,6 g/cc and said explosive composition having a bulk density of from 0,5 to 1,1 g/cc. Vegetable protein in the form of legumes (e.g. peanut shells and walnut shells) are disclosed.

One commercially available explosive composition with a reduced density comprises 16 to 22wt% rice hulls, 30 to 50wt% ANFO and 20 to 40wt% water-in-oil emulsion. The rice hulls used in this composition have a density of about 0,16 to 0,17g/cc allowing for the preparation of explosive compositions with a density in the range of 0,45 g/cc to 0,65 g/cc . If such explosive compositions with densities of below 0,45g/cc are to be prepared, more than 26wt%of the bulking agent in the form of rice hulls are required. This is problematic because the resultant explosive lacks sufficient explosive power to efficiently break and move soft or well-jointed rock. This is due to both the increased volume of rice hulls and reduced explosive components, together with the increased oxygen negativity of the explosive composition, further reducing the explosive power output. The only method available to generate sufficient explosive energy in these cases is to increase the volume of low density bulk explosive, per unit volume of material being blasted. This then negates the efficiencies offered in using the lighter density explosives.

In formulating explosive compositions with a reduced density it has always been problematic to identify a density reducing bulking agent which is easy to handle,

blends easily, is non-toxic, is almost inert, does not effect emulsion stability, does not contain free water, is cost efficient, to name a few.

It has now been found that if hulls of de-hulled rice are treated to remove finer material therefrom, then the resultant treated hulls have a lower density than before. Such treated rice hulls have now been found to be suitable to be used as the density controlling component in the preparation of stable explosive compositions, especially with a density of less than 0,5 g/cc, and which do not have an unacceptable high concentration of the rice hulls.

The effect of the change in density of the treated rice hulls on the explosive composition could not have been predicted since the density of a multi component bulk explosive mix is not linearly related to the density of the bulking agent . This is due to for example, the porosity created by the AN prills and rice hulls. The treatment of the rice hulls could also have a negative influence on characteristics such as ease of blending, stability and the like.

DISCLOSURE OF THE INVENTION

According to the present invention there is provided an explosive composition comprising a mixture of an oxidiser component; a fuel component; and a density controlling component in the form of hulls of de-hulled plant grain, which hulls have a density of less than or equal to 0,14g/cc.

The hulls of de-hulled plant grain preferably comprise rice hulls with a density of less than or equal to 0,14g/cc.

Preferably the rice hulls have been treated to remove the rice hull fines to reduce the density of the rice hulls to less than or equal to 0,14g/cc.

The explosive composition may have a density of less than 1,1g/cc preferably below 0,5g/cc and more preferably from 0,49g/cc to 0,25g/cc. In one embodiment the density of the explosive composition may be 0,45g/cc or below.

The density controlling component is preferably added to comprise less than 36wt%, preferably less than 30wt% of the explosive composition, or more preferably below 26wt%. Most preferably less than 19wt% of the density controlling component is used to prepare an explosive composition with a density of less than 0,5g/cc.

The oxidiser component may comprise any suitable component. Preferably it comprises an ammonium nitrate (AN) product, such as prilled AN or porous prilled AN (PPAN).

The fuel component may comprise any suitable fuel such as a liquid or solid fuel. In a preferred embodiment the invention the fuel component comprises a liquid fuel, preferably an oil, preferably a mineral oil, for example diesel.

In one embodiment of the invention the combined oxidiser and fuel components may comprise ANFO which is a combination of ammonium nitrate (AN) and fuel oil (FO). In one embodiment of the invention the combined oxidiser and fuel components may comprise heavy ANFO which is a combination of ANFO with an emulsion. The emulsion may comprise an aqueous emulsion of an oxidiser component (preferably a salt such as AN or a combination of salts, such as AN, calcium nitrate and sodium nitrate) as a discontinuous phase in a continuous oil phase. The emulsion may also include an emulsifier, for example a PIBSA derived emulsifier.

In one embodiment of the invention the explosive composition may comprise an emulsion explosive. In another embodiment of the invention the explosive composition may comprise a watergel (an oil in water) explosive.

According to another aspect of the present invention a method of preparing an explosive composition comprises mixing together

- an oxidiser component;
- a fuel component; and
- and a density controlling component in the form of hulls of de-hulled plant grain, which hulls have a density of less than or equal to 0,14g/cc.

The invention also relates to an explosive composition prepared by the method as set out above.

The invention will now be further described by means of the following non-limiting examples:

Comparative Example 1

An explosive composition with a density of 0.45g/cc was prepared by mixing the following components together (including rice hulls of a density of 0,16g/cc):

1.1 An amount of 435grams of an oxidising component in the form of AN nitrate prills of 0.78g/cc.

1.2 Diesel fuel oil in an amount of 9grams.

1.3 An amount of 260grams rice hulls. The rice hulls had a density of 0,16g/cc.

1.4 An amount of 296grams water-in-oil emulsion, which emulsion is an ammonium nitrate (AN) emulsion with the typical composition of 77.18 wt% AN; 15.82 wt% water; 5.4 wt% diesel and 1.6 wt% emulsifier with a density of 1.33g/cc.

The prills were placed in a stainless steel bowl and the diesel was added thereto. The mixture was stirred in order to get a good mix of the prills and diesel. To this was added the water-in-oil of emulsion, and the resultant mixture was stirred to obtain a uniform consistency. The rice hulls were then blended with this mixture until a uniform consistency was obtained.

The explosive composition had a density of 0,45g/cc and produced energy of approximately 2,5Mj/kg, derived by using an energy of 3.7Mj/kg for 0.8g/cc ANFO and 2.9Mj/kg for the 1.33g/cc density emulsion, and assuming that the rice hulls are thermochemically inert. This equates to a relative weight strength of 0,68 and relative volume strength or bulk strength of 0,38 compared to ANFO.

Example 2

An explosive composition with a density of 0,45g/cc was prepared by mixing together the following components (including rice hulls of a density of 0,11g/cc):

2.1 An amount of 488grams of an oxidising component in the form of AN prills of density of 0.78g/cc.

2.2 Diesel fuel oil in an amount of 10grams.

2.3 An amount of 170grams rice hulls with a density of 0.11g/cc.

2.4 An amount of 332grams of the same emulsion as in example 1.

The explosive composition was prepared in the same way as set out in example 1 and had a density of 0,45g/cc. The explosive has an energy output of approximately 2.81Mj/kg which equates to a weight strength of 0.76 and a bulk strength of 0.43 compared to ANFO.

The explosive composition of Example 2 has the following advantages over the explosive composition of Comparative Example 1:

- Although the densities are the same for both compositions, the energy provided by the composition of Example 2 is 11.2% higher than that of Comparative Example 1 (2.81Mj/kg versus 2.50Mj/kg).
- The relevant weight strength of the composition of Comparative Example 1 is 11.7% lower than that of Example 2.
- The relevant bulk strength of the composition of Comparative Example 1 is 13.1% lower than that of Example 2.
- The composition of Example 2 will produce better blasting outcomes than that of Example 1 for the same given volume of explosives.